Entropy Production and Life

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Living things, like other physical systems, produce entropy. Since entropy production scales with the intensity of metabolism, growth, and processing of information, it follows that systems that produce entropy at higher rates will outcompete other systems. There is therefore a natural tendency for systems to evolve to states of higher entropy production.

Many nonliving systems, including the climates of Earth and other planets, show an empirical preference to be in states that maximize the production of entropy.

This principle of maximum entropy production (MaxEP) has recently been shown by Dewar to follow as a general result from the statistical mechanics of nonequilibrium systems : the same analysis leads to the fluctuation theorem and the emergence of Self-Organized Criticality (SOC) in weakly forced systems.

This tendency to maximize entropy production contrasts with the ordered nature of living things – a low configurational entropy state. In order that ordered structures are not destroyed, their entropy production must be exported to the environment.

A universal feature of systems (both living ones, and non-living ones like convective systems, hurricanes, evolution of river networks etc.) is that they are phenomenologically interesting. Analyses of these systems from an entropy and entropy production standpoint offers a new perspective on them. I review recent developments in MaxEP and their potential application to Astrobiology.